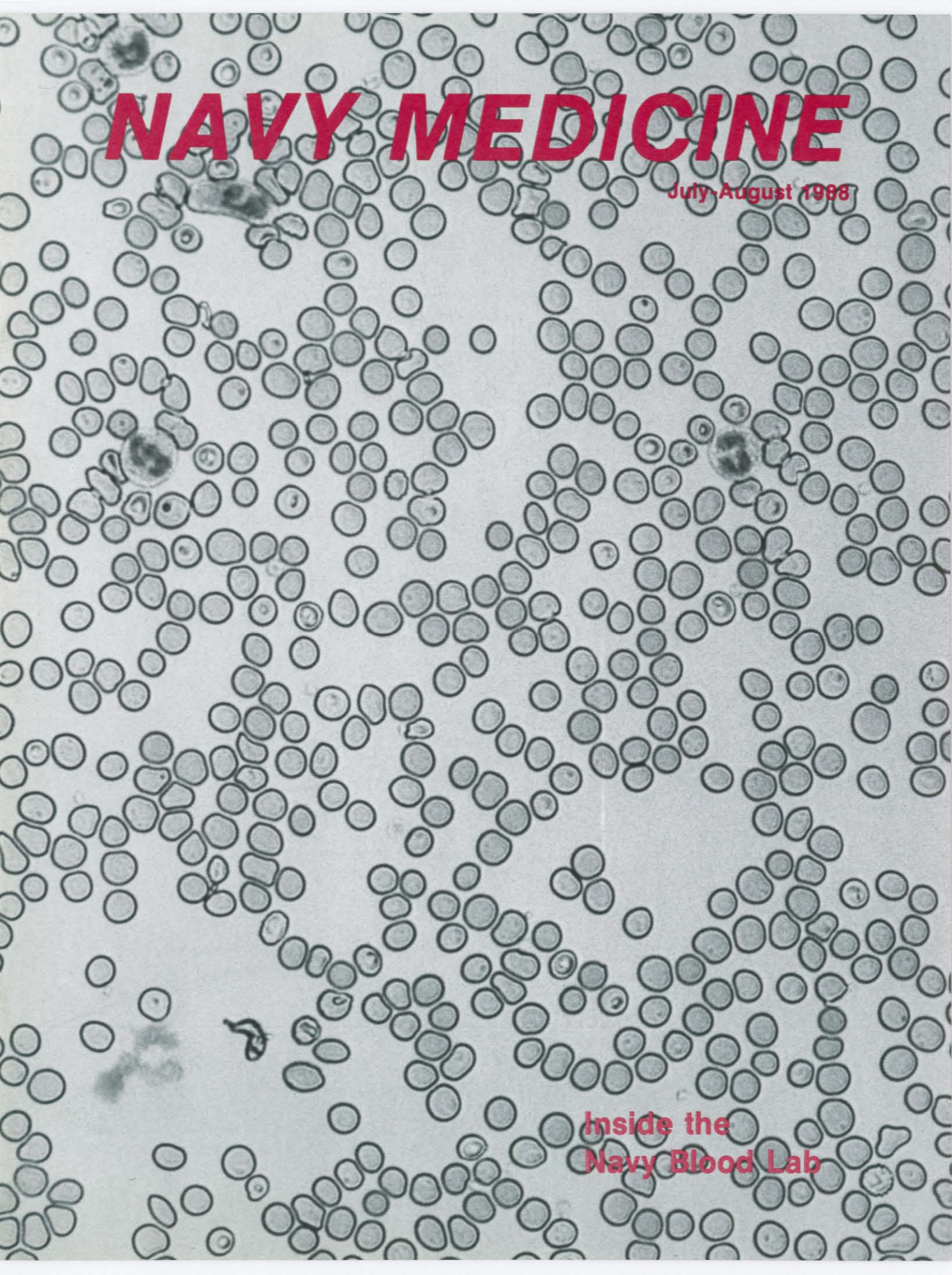

NAVY MEDICINE

July-August 1988

Inside the Navy Blood Lab

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NAVY MEDICINE

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COVER: Red blood cells magnified over 500 times. Since freezing its first unit of blood in 1966, the Naval Blood Research Laboratory in Boston, MA, has been a leading innovator in blood preservation technology. Story on page 7. Photo by HM3 Louis Curtis, Jr., NSHS, Bethesda, MD.

Navy Medicine:
A Year Later

Slightly more than a year ago, I became Surgeon General of the Navy. Shortly thereafter, in this publication, I told you that we needed to change the way we did business in the Medical Department. I told you that change—for the better, not merely for its own sake—would be the blueprint for Navy medicine's future, and that we would all have a job to do in the building. Like all construction work, we had to start with the foundation.

In the near future, I will be sending you an "annual report" which spells out in detail the steps taken to revitalize Navy medicine in the past year. It is my belief that we have stopped our downward slide and laid the foundation for the future. I believe also that our military and civilian superiors are prepared to give us adequate resources to begin restoring Navy medicine to a position of leadership in education, research, and health care delivery.

The annual report lists our progress in a number of important areas. Through our reports, testimony, and educational efforts, we have gained the attention and support of leaders in Congress, the Department of Defense, and the Navy Department. A "Blue Ribbon" Flag Officer Panel created to study our active duty staffing has supported increased compensation. Our recruiting efforts are improving. We are beginning to turn around the decline in our education programs. Automation is promising to reduce the number of hours required for many administrative tasks, freeing personnel for more direct physician support. A review of our quality assurance programs confirmed that the quality of Navy care is exceedingly high, and we have begun to revise QA directives to make the process less punitive. Our readiness to go to war with the operating forces and keep them in the battle is better than it has been in many years. In nearly all areas we see signs of positive change.

To ensure this progress, I need the assistance of innovative, experienced professionals, with an intimate knowledge of our problems and our strengths. You are the ones who have already made significant contributions and sacrifices for our community; you are the ones who will succeed wherever you endeavor. I hope you will see the improvements we have made this year as the first fruits of your efforts, not the whole harvest. Stay with us, and become one of those who will shape the revitalization of Navy medicine in the years to come.

VADM James A. Zimble, MC

NAVMEDCOM Archives

Navy ambulance boat had a top speed of 11.5 knots and accommodated 24 stretcher and 12 ambulatory patients.

A look back: Navy medicine 1919

Let's Remember R & D

In operating a worldwide medical system of hospitals, clinics, and facilities with the forces afloat, we sometimes overlook one of the great strengths which enables us to practice the superb quality of medicine for which the Navy is famous. Few medical organizations in the world can look behind them to the comprehensive and excellent research and development organization which we have. From Medical Research Units in Cairo, Manila, and detachments in Indonesia and Peru to the CONUS-based medical and dental research organizations which span aviation, submarine, surface medicine, advanced research, and environmental health, we have one of the great not-so-secret weapons in the war against disease.

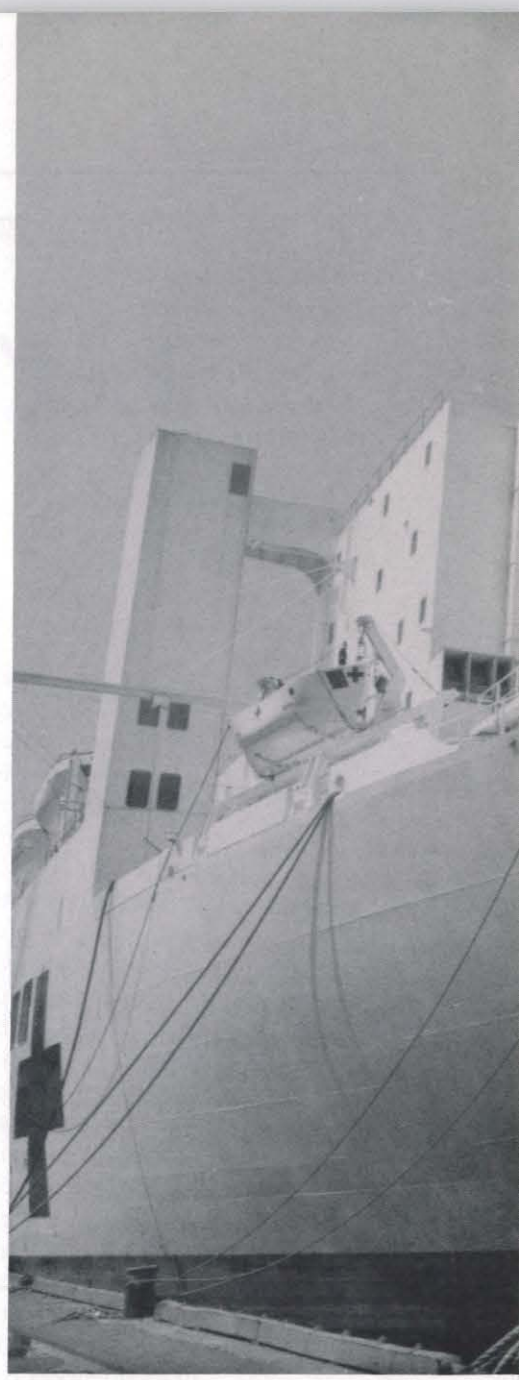
Few of the patients who pass through the doors of our medical treatment facilities realize the superb backup to the clinical effort which is being brought forth every day by researchers in all disciplines in our far-flung laboratories. Few of our countrymen are aware of the numerous and diverse discoveries which Navy medicine and its laboratories have brought to medical science as a whole, ranging from some of the most important blood research of the 20th century, through aerospace medicine which has brought us across new frontiers in the universe, to epidemiological discoveries which have lightened the toll of illness and death throughout the world.

We in Navy medicine should be the last to take our colleagues in the research and development area for granted, for each of us profits in our clinical and operational practice, and in augmenting the readiness of our forces, as the result of their work. Like the faithful friend who is always there, so too is our research effort, always being relied upon, and perhaps not always receiving just due for loyal and superb contributions.

I call upon members of all corps not only to take a closer look at Navy medicine's distinguished research and development record but to consider becoming a part of it yourselves. In the war against disease we need fresh, enthusiastic reinforcements. It is a career opportunity worth checking out.

RADM Joseph S. Cassells, MC

Comfort Arrives in Baltimore



A 1,000-bed hospital literally floated into the Port of Baltimore on 13 June 1988. The USNS *Comfort* (T-AH-20), the Navy's second hospital ship, steamed into the Port of Baltimore and anchored at the Dundalk Marine Terminal. In a ceremony commemorating the arrival of *Comfort* held pierside on 17 June, RADM J.S. Cassells, MC, Commander, Naval Medical Command, hailed the ship's capabilities. "*Comfort* represents the state of the art in areas vitally important to the military readiness of this Nation and to the humanitarian task of serving those who have borne the burden of battle in the Nation's behalf," stressed the admiral. The ship's sponsor, Mrs. Rose Narva, wife of RADM William M. Narva, MC, the attending physician to Congress, presented the ship with an oil portrait of the *Comfort*. During public tours of the ship held 18-19 June, 2,500 people visited *Comfort*.

Comfort's layberth for the next 5 years will be at Canton, also within the Port of Baltimore. The vessel is a converted tanker and the third hospital ship to bear the name. Previous *Comforts* (AH-3 and AH-6) distinguished themselves in service during the World Wars.

Comfort is assigned to the Commander, Military Sealift Command, Atlantic, and is crewed by civilian mariners. The Medical Treatment Facility (MTF) is staffed with medical and nonmedical active duty Navy personnel.

During its conversion, the ship's original fuel tanks were replaced by prefabricated modular units containing various medical support and operating areas. *Comfort* provides an afloat medical facility that is mobile, flexible, and responsive. It has the latest in up-to-the-minute medical technology, including the world's first shipboard computerized axial tomography (CAT) scanner in a seagoing vessel. *Comfort* has diagnostic capabilities never before available at sea. As noted by RADM Cassells, "The ship is a reflection of the highest technology available in the world today."

Normally the ship will be in reduced operation status in her layberth and maintained by a small nucleus crew of 13 civilian mariners. A crew of 40 Navy personnel under an officer-in-charge will maintain the readiness of the MTF. When required, *Comfort* can make the transition to full operating status within 5 days. The civilian mariner crew will increase to about 70 and the MTF to about 1,200. The augmenting Navy personnel will be provided by the Naval Medical Command, principally from the Baltimore-Washington area.

When operating at full status, *Comfort* can support a 1,000-bed medical facility, 12 operating rooms, a dental facility, and around-the-clock medical support services. Currently, *Comfort* does not have orders to deploy. She will remain in her layberth pending receipt of orders. □

—Story by LT Michael E. Neruda, USNR-R, Office of Information (DET 206), Washington, DC.

CAPT J. Marcias, USNR-R

Military Sealift Command

Pierside in Baltimore.

Comfort **transits the Panama Canal enroute to her new homeport.**

An M-60 tank is positioned so workers can clean underneath it. Below: HMC Woy (right) confers with HMC Cliff Carter on a busy day at the vehicle washdown site at Pohang, South Korea.

The Final Washdown

If you ever wondered how much mud can accumulate on a Marine M-60 main battle tank, just ask HMC Kenneth Woy of the combat service support element of the 1st Marine Expeditionary Brigade from Kaneohe Bay, HI. For 5 years, Woy, a preventive medicine technician, has been responsible for making sure all the Korean mud picked up by several thousand vehicles involved in Exercise Team Spirit stays in Korea.

"During the final washdown before all the vehicles are backloaded aboard ship, we'll be washing and inspecting 300 vehicles a day," Woy said. "Everything from jeeps to gasoline tanker trucks and self-propelled howitzers. I've seen about 500 pounds of mud washed off an M-60 tank."

With four other hospital corpsmen, and a half dozen Korean workers, Woy ensures that no plant or animal material is carried back to the ships on the vehicles.

"We look closely inside and out for insect larvae and eggs, fruit flies, and beetles," he said. "All the rolling stock must pass strict quarantine inspections.

"We're all pretty pooped at the end of a 12-hour day. No one likes to be told that they've missed a spot, but we have exacting standards. Using two sites, it takes us about 10 days to complete the washdown and inspections," Woy said. □

—Story and photos by PHC Chet King, Seventh Fleet Public Affairs, Subic Bay, R.P.

The Navy's Blood Pioneers

HM3 Louis Curtis, Jr.

Since the introduction of AIDS into our vocabulary, there has been heightened awareness about the safety of the nation's blood supply. However, the subject of blood —purity, processing, preservation, availability—is nothing new. For years both civilian and military researchers have been hard at work. One laboratory in particular is renowned as the most productive blood research organization in the United States, if not the world.

Operating out of a modest brick building adjacent to Boston University Medical Center, the Naval Blood Research Laboratory (NBRL), directed by CAPT C. Robert Valeri, MC (Ret.), has consistently been the leading innovator in the development of blood preservation technology.

NBRL was born in 1965 at Naval Hospital, Chelsea, MA, and it was there that Dr. Valeri and his staff developed techniques for preserving and storing blood for extended periods. With the disestablishment of the lab in 1979, NBRL changed its status but not its focus by becoming a Navy-owned

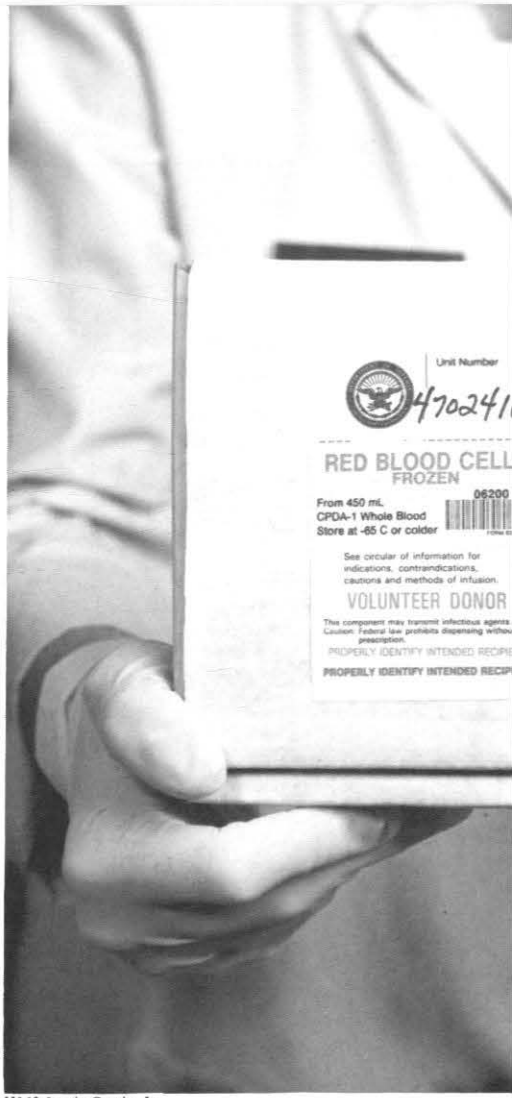
In the Naval Hospital, Bethesda blood bank, HM3 Mark Martin deglycerolizes a unit of previously frozen red cells with a cell washer. Similar equipment is now standard in other Navy blood banks ashore and afloat.

Photo by the Editor

A unit of frozen red cells with its cardboard container.

Photo by the Editor

Frozen platelets and aluminum storage container.



HM3 Louis Curtis, Jr.

and contractor-operated university facility. The contractor is Boston University and, besides serving as NBRL's scientific director, Dr. Valeri is professor of surgery at Boston University School of Medicine.

The partnership between the Navy and the university has developed into an extremely fruitful one. In return for its support the Navy, the other military services and, in fact, the civilian sector, have reaped the benefits of the lab's expertise.

NBRL's most notable breakthrough has been in blood preservation. During the Vietnam War half of the whole blood shipped to the war zone and having a shelf life of 21 days (this has since been extended to 42 days) became outdated and ended up having to be discarded, points out Marilyn Leavy, the lab's administrative officer. It was therefore necessary for fresh blood to be flown in regularly to satisfy demand. It became evident that

Although this unit of frozen red cells will not be used beyond its August 1998 expiration date, NBRL researchers have found that frozen red cells can survive over 20 years.

there had to be a more reliable source.

In 1966 NBRL shipped its first unit of frozen blood to Vietnam, and since then it has perfected the technology. Now red cells frozen for over 21 years can be thawed, washed, and transfused. This has revolutionized blood banking for the military. Universal donor O positive and O negative blood is drawn, tested for HTLV III and hepatitis B, frozen, and prepositioned in blood banks ashore and afloat throughout the world.

Moreover, the technology required to freeze and then thaw and prepare blood products for use is relatively uncomplicated, says Alan Gray, supervisor of NBRL's processing division. "Our techniques are very simple and reproducible. There's nothing high-tech about it." All frozen blood products and systems designed by the lab are stored at -80° C in a mechanical rather than an expensive liquid nitrogen freezer.

The Process

What is NBRL's technique for freezing blood? The unit is initially collected in an 800 ml polyvinyl bag developed by the lab. (The standard collection bag is 600 ml.) Three satellite bags are already connected to the primary bag by tubing, and there is also a special adaptor port for sterilely introducing or drawing solutions from the primary. Technicians then place the bag of whole blood in a centrifuge, where the unit is spun into its components—platelets, plasma, and red cell concentrate.

Within 6-8 hours the platelets must be frozen in a 6 percent solution of dimethylsulfoxide (DMSO), a cryopreservative. Technicians must also treat the red cells with the cryopreservative, glycerol. If frozen without being glycerolized, ice will damage the cell walls and render the red cells useless.

Once glycerolized, the red cell concentrate is stored in cardboard containers. These boxes, costing about 15 cents, were developed by NBRL. Blood has traditionally been frozen and stored in aluminum containers costing about $18. These tins were not only expensive but contributed to high levels of unit breakage during shipping, sometimes amounting to a 15 percent loss. With cardboard, loss is less than 3 percent. The tins also add considerable weight to the stored blood units. With impact-resistant cardboard packaging, critical tabs and tubing segments are protected. There is also ample room in the cardboard container for both the primary bag and plastic tubes of plasma samples from the unit for future testing. This allows for the unit to be tested without violating its sterility. If the test is negative, the entire unit need not be discarded. In addition, the lighter package occupies half the volume, a considerable advantage considering the limited space aboard ship.

The package is then frozen and stored at -80° C in a mechanical freezer. When needed, the overwrapped bag of red cells is thawed at 42° C for 20-25 minutes in a circulating water bath that accommodates up to 12 units.

The now thawed red cells must be washed with a sodium chloride-glucose solution in a specially designed blood processor. Earlier wash methods required 6.8 liters of wash solution; now 1.5 liters are sufficient to remove over 99 percent of the glycerol.

After washing, the unit is spun at 5,800 rpm to recover the red cells and then technicians culture each unit to determine sterility.

Following this regimen, NBRL researchers have demonstrated that frozen red cells, once thawed and processed, are highly viable when transfused. No less significant is the proven safety of the product. Tests have determined that previously frozen red cells have a shelf life of up to 72 hours, not 24, which is the current industry standard for unfrozen blood.

Rejuvenation

Normally, unfrozen blood can be refrigerated for up to 42 days before losing its potency. It then must be discarded. Dr. Valeri and his researchers have synthesized an inexpensive "cocktail" they call PIPA (pyruvate, inosine, phosphate, adenine). When added to "old" blood, PIPA rejuvenates it; after treatment the red cells are comparable to week-old blood. Units that once exceeded their shelf lives and had to be discarded can now be saved.

In certain instances rejuvenation can be performed within a 3- to 5-day

Below: **Pyruvate, inosine, phosphate, adenine (PIPA) is used to rejuvenate red cells.** *Right:* **HM3 Tom Verginas, NAVHOSP Bethesda, uses a plasma extractor to remove excess glycerol from a unit of red cells prior to freezing.**

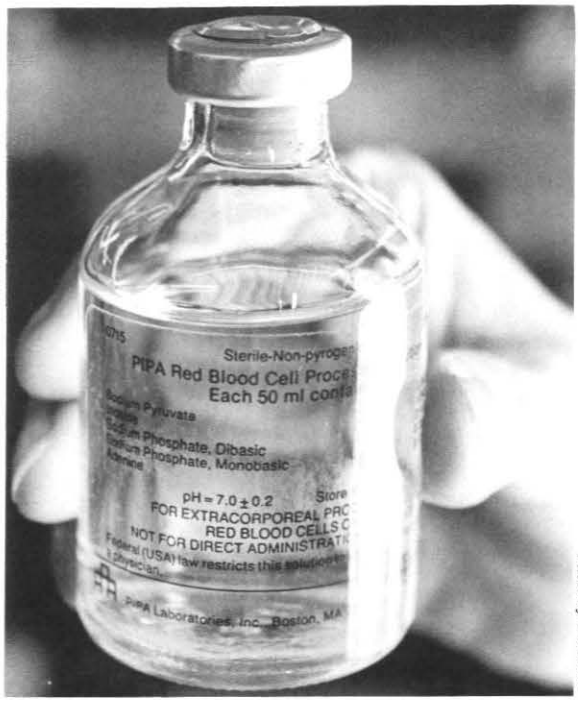


Photo by the Editor

period following donation, allowing "super cells" to be made. These cells have a high capacity to deliver oxygen and have been found to benefit critically ill patients.

With NBRL's 800 ml blood bag system, blood can be collected, components separated, rejuvenated, frozen, thawed, and washed all in the same bag. With the increased bag volume, there is ample space for proper mixing of glycerol and if PIPA needs to be added. (It should be noted that before transfusion, PIPA, like glycerol, must be washed from the red cells.)

REFLUPS

Recognizing the need for reliable quantities of sterile wash solution aboard ship, NBRL has stimulated the development of the Resuscitation Fluid Production System (REFLUPS). The system utilizes the principle of reverse osmosis and filtration to purify water and filter out bacteria.

A major problem in the past has been the availability of sterile water aboard ship. Sterile water produced by REFLUPS equipment can be used to prepare resuscitation fluids such as lactated Ringer's solution and sodium chloride, sodium chloride-glucose wash solution, and water for injection.

According to Marilyn Leavy, the machinery can run up to 22 hours a day and produce 18 1-liter bags of sterile solution at a time.The lab is currently testing solutions made aboard USS *Saipan*; USS *Nassau*; at the Naval Ocean Systems Center, San Diego; and at NBRL for sterility, endotoxins, and chemical composition.

Third Generation Cell Washer

In its ongoing effort to improve blood processing technology, NBRL is currently testing what is called a third generation red cell washer that, like the REFLUPS, utilizes membrane technology to filter red cells from their glycerol protector. This cell washer will obviate the use of mechanical spinning with its requisite rotating seals—seals that could fail and compromise sterility. Moreover, the new cell washer is smaller, lighter, and will operate in almost any environment ashore or afloat.

An additional development is a closed system using sterile docking devices. The system will enable previously frozen washed red cells to be stored in an additive solution to maintain viability and function for at least 2 weeks.

Intraoperative Blood Recovery

One of the most exciting research projects underway at NBRL is the evaluation of new technology for intraoperative blood recovery. Recover-

HM3 Louis Curtis, Jr.

ing a patient's blood either from an injury or surgical site, then washing, filtering, and reinfusing it into the patient has two key advantages. The risks of incorrect matching and cross-infection are eliminated.

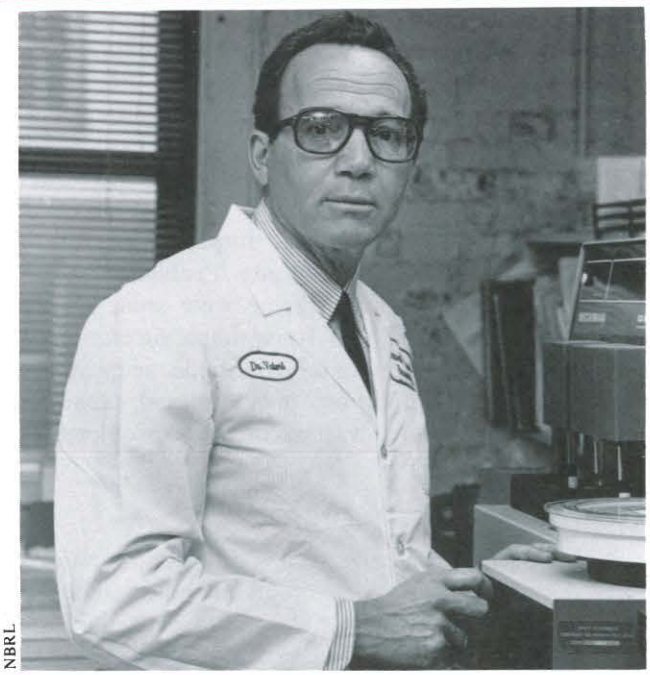
Presently, the lab is doing cooperative studies with the West Roxbury, MA, Veteran's Administration Hospital. Thus far the research has been limited to elective surgery cases because the quality of shed blood from a trauma site—gunshot, stab wound, or accident—is too uncertain.

According to Alan Gray, successful recovery and treatment of blood from traumatic injury victims is fraught with complications. Many questions yet need answers, not the least of which is what to do about clotting. "When you're injured, you hope that as a patient, your blood begins to clot," points out Gray. "If we collect it improperly you end up with nothing but clotted blood."

Under closely monitored and controlled elective surgery, patients are first heparinized to thin their blood. The shed blood from the surgical site is carefully collected by aspirator and washed with sodium chloride, after which the red cells are collected and reinfused. "We have to find the best way to wash the blood," says Gray, "and eliminate the activated material (clots) so that what we are reinfusing is a safe product."

Because of its reputation for providing a safe product, the lab has increasingly served as a model for blood banks and other research labs. With the AIDS scare and increased concern about other blood-borne diseases, more and more private companies and hospitals interested in setting up their own frozen blood banks either call or visit. In response to that demand, the lab has made available to the civilian community videotapes originally prepared for the Navy and the Department of Defense for training personnel to operate deployed frozen blood banks.

NBRL began its mission of ensuring safe blood products for the Navy over 23 years ago. By expertise and productivity, that constituency now includes all mankind. —JKH



NBRL

Dr. Valeri Receives Conrad Award

CAPT C. Robert Valeri, MC (Ret.), scientific director of the Naval Blood Research Laboratory, Boston University School of Medicine, received the Captain Robert Dexter Conrad Award from Asst SECNAV (RE&S) Thomas F. Faught, Jr., on 12 Aug 1988 for his monumental contributions to the Navy Blood Program. His efforts in developing methods to store and freeze human red blood cells and platelets have brought him and the Navy international acclaim. One of Dr. Valeri's many outstanding accomplishments involved extending the shelf life of frozen red cells from 3 years to more than 20 years. He is recognized as an expert in blood preservation and transfusion therapy.

The annual research award consists of a gold medal and citation from the Secretary of the Navy for widely recognized achievement in research and development.

GMO Year at a Branch Medical Clinic

A Retrospective Review

LCDR Robert J. Backer, MC, USNR

Many of the young physicians in military medicine are there by virtue of the Armed Forces Health Professions Scholarship Program. In return for medical tuition, books, and supplies, the candidate is required to serve in the Medical Corps of the branch of the military that he/she joined. In the Navy the physician also agrees to serve as a general medical officer (GMO) for 1 year after the first 12 months of postgraduate training if this fills the need of the fleet and the Medical Corps. After the GMO year the physician is allowed to return to finish his/her postgraduate training.

Some may wonder if 1 year of postgraduate training is sufficient to manage the problems a GMO might encounter. In order to shed some light on this I would like to review my experience as a GMO from 1982 to 1983 at a branch clinic. Following are the results of a retrospective chart review outlining how problems were handled at the clinic and what cases had to be sent to the Naval Regional Medical Center.

The Branch Medical Clinic, Naval Air Station, Whiting Field, is located approximately 22 miles northeast of Pensacola, in the Florida panhandle. The population served consists of approximately 2,200 active duty personnel, and a dependent and retired population of approximately 10,000. Supportive services are available at the Naval Hospital, Pensacola and the medical center at Eglin Air Force Base. The branch clinic consisted of six departments: administration, active duty sick call, outpatient clinic, laboratory and X-ray services, emergency room (ER), and pharmacy.

Active duty sick call was staffed by four flight surgeons and the outpatient clinic by three GMO's, one civilian doctor and one physician's assistant. The outpatient clinic was responsible for all dependents and retired personnel. An average of 2,000 patients were seen each month. Patients were seen by appointment and then on a walk-in basis if appointments were full for the day. Emergencies and most lacerations were sent to the ER. One physician covered the ER during the day and had his appointments cut by approximately one-fourth in hopes that his scheduled patients would not be kept waiting. ER coverage rotated on a daily basis and watches were stood staffing the ER at night and on weekends. The number of overnight watches varied throughout the year but averaged about every 8th night.

The age of patients seen in the outpatient clinic ranged from 1 month to the ninth decade. Problems related to almost all specialties of medicine were seen. Problems managed in the ER ranged from simple lacerations and fractures to acute paranoid schizophrenia, acute appendicitis, myocardial infarction, and ruptured tubal pregnancy. Overall, a large variety of clinic problems were encountered.

Methods

A random, retrospective review of 400 charts was performed identifying the chief complaint and whether or not diagnosis and treatment were carried out at the branch clinic or required referral to one of the support hospitals. All patients seen by a physician were logged in on daily

appointment sheets. These sheets then served as a data base from which charts could be pulled. Appointment sheets from September 1982 through March 1983 were retrieved and shuffled. Random selection of appointment sheets was performed and the charts pulled for all patients seen on that day. Charts were then labeled as to being pulled and were not allowed to be repulled unless the patient was being seen for a new problem. Therefore, a patient's chart may have been used more than once in the total 400 cases reviewed as long as each visit represented a new complaint unrelated to previous ones.

The table is an alphabetical listing of the complaints/diagnoses found in the 400 visits reviewed. Overall, 95 percent of the patient complaints could be treated at the branch clinic. Five percent (20 cases) had to be referred and were then followed either at the support hospital or at the clinic based on recommendations from the consulting specialty. The referred problems were as follows: one case of unstable angina, one carpal tunnel for surgical evaluation, two cases of lumbar radiculopathy and possible herniated disc, one radius fracture, one contracture, one chronic bursitis, one DeQuerven's tenosynovitis, one case of amenorrhea, one case of dysfunctional uterine bleeding, one case of chronic pelvic pain, one pinguecula, one acute arthritic joint, one chronic laryngitis, three chronic otitis media, one enlarged tonsils and adenoids, and two cases of chronic draining paronychia not responding to antibiotics.

Complaint/Diagnosis

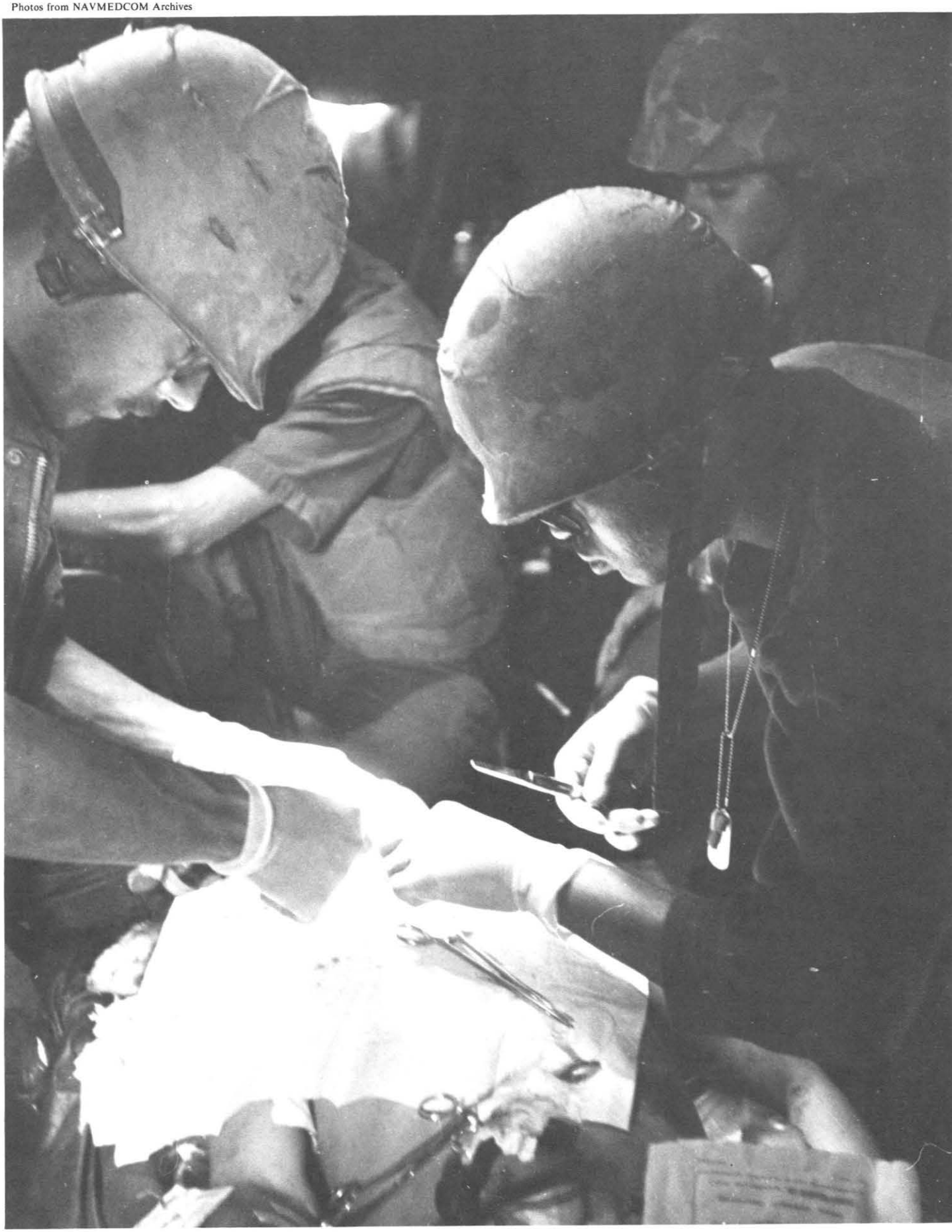
Abdominal pain	Hematoma (soft tissue)
Acne	Hemorrhoid
Amenorrhea	Hypertension
Angina	Laryngitis
Arthralgia	Lice
Arthritis	Mitral valve prolapse
Asthma	Mononucleosis
Bites	Myalgia
Bronchitis	Otitis media
Bursitis	Paronychia
Carpal tunnel	Pelvic pain
Cervicitis	Pharyngitis
Contraception	Physical exam
Contracture	Pinguecula
Dehydration	Pneumonia
Dysfunctional uterine bleeding	Radiculopathy
	Rash
Dysphagia	Rhinitis
Encopresis	Seizures
Eustachian tube dysfunction	Sinusitis
	Tenosynovitis
Fracture	Tinnitus
Functional bowel	Tonsillitis
Gastroenteritis	Vaccination
Headache	Vaginitis
Hematochezia	Vertigo
	Viral syndrome

Discussion

It appears that many of the initial visits to the outpatient clinic can be managed at the primary care level. Furthermore, the nature of these problems and their degree of difficulty were such that 1 year of postgraduate training in a well-rounded internship was sufficient to treat and/or recognize the need for evaluation by a specialist. While none of us is overjoyed with the idea of interrupting our training after 1 year, a need does appear to exist for physicians with this level of education. This seems to be the logical time for a break in training after a hustling internship and before becoming entrenched in specialty training. For me the GMO year meant handling a variety of clinical problems, having time to read, visiting with friends, and getting reacquainted with family. I certainly was not disappointed. □

Dr. Backer is a neurosurgeon assigned to the Brooke Army Medical Center, San Antonio, TX 78232.

Photos from NAVMEDCOM Archives



Conceptual Errors in Combat Casualty Care Training

How to Reverse Them

CAPT Arthur M. Smith, MC, USNR
COL Ronald F. Bellamy, MC, USA

During the Falklands war, patients treated by Argentine military physicians encountered untoward numbers of gas gangrene wound infections. As compared to the British, who had continuing experience with war wounds in Northern Ireland, Argentine physicians ignored the time-tested fundamental war wound management principles first described by surgeons supporting the army of Napoleon.

Military surgical history is replete with examples of such lessons painfully learned in previous wars, which were allowed to lay fallow between conflicts, and which had to be relearned in subsequent ones. This knowledge gap occurs, to a large degree, because surgeons devote their peacetime efforts primarily to elective operative procedures. Trauma surgery, commonly, is not the principal focus of their professional activity. On those occasions when trauma surgery does command attention, it is often clothed in a predominantly civilian peacetime framework.

While discussing this paradox, an experienced U.S. combat surgeon wrote, "In the comparative luxury of the Vietnam war, many medical officers were shocked by the occasional need to change the pattern of patient care from that which they practiced in civilian life. Physicians are generally a rigid, compulsive group, and in many cases the cultural, professional, and emotional shock of having to compromise or modify patient care actually immobilized or rendered unfit the physician suddenly placed in the combat zone."(*1*)

Vietnam 1968: A Navy physician performs emergency surgery during the siege of Khe Sanh.

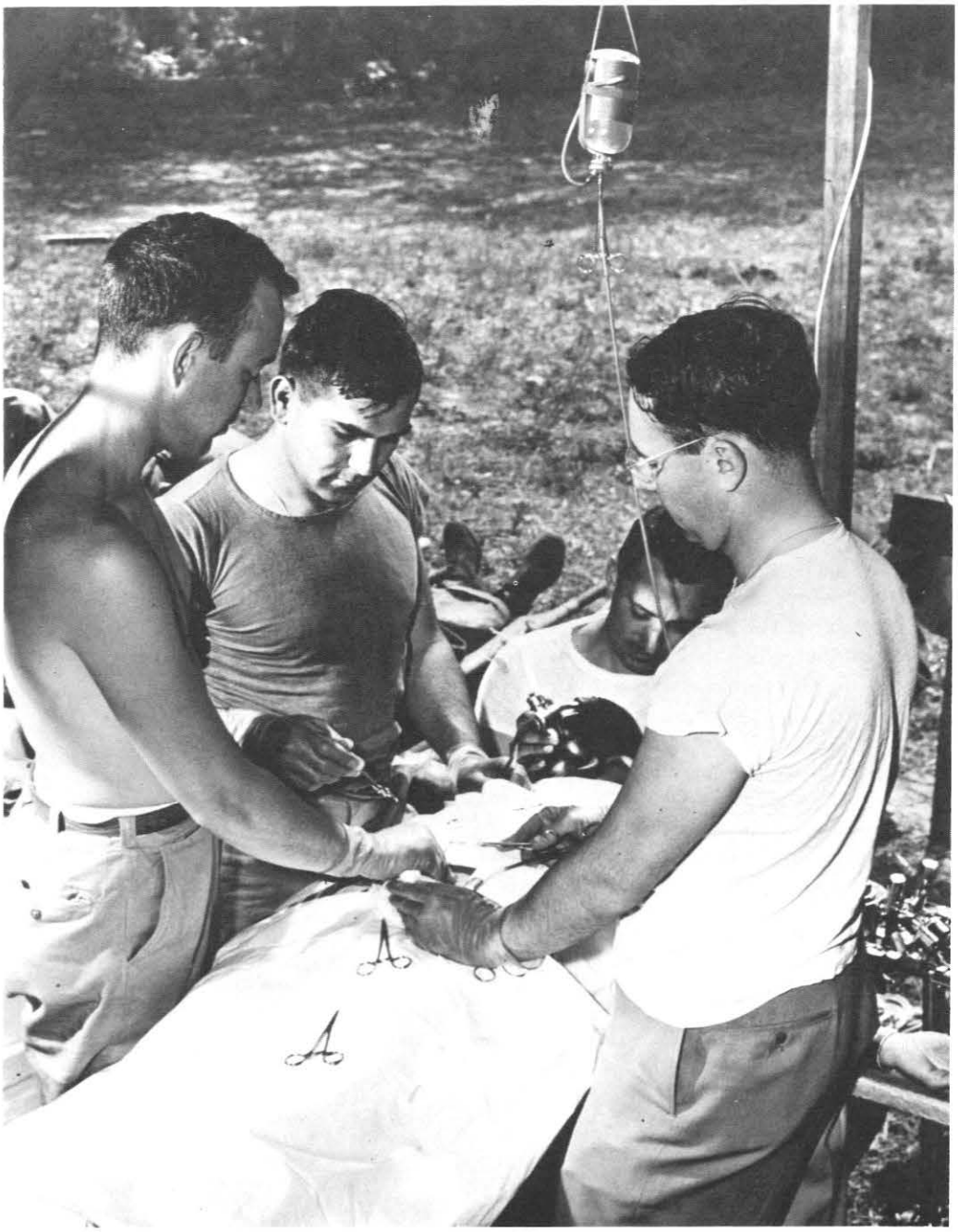
What Makes Combat Surgery Different?

Although all patient care within the military setting is ultimately rooted in the basic principles of medical and surgical practice, specialized knowledge is required for adapting these principles to military realities. For example, the spectrum of injury is different (Table 1). Casualty data demonstrate that more than 90 percent of Vietnam ground combat deaths were caused by penetrating missile wounds. Compared to the civilian sector, the incidence of penetrating trauma is much less; in one recent study it was responsible for only one-third of total trauma deaths. In addition, not only must the military physician in combat provide care for patients with missile, blast,

TABLE 1
Expected Distribution of 10,000 Hits by Regional Location and Type of Casualty Reporting*

	Total Hits	Died	Living WIA
Head, face, neck	2,095	987	1,108
Thoracic	1,325	567	758
Abdominal	751	379	372
Upper extremity	2,337	116	2,221
Lower extremity	3,492	239	3,253
Totals:	10,000	2,288	7,712

*Based on aggregate World War II data from all theaters



Korea 1951: Emergency surgery in the field.

Professional Preparation

Traditionally, the military surgeon has received his indoctrination to wartime surgery largely on an on-the-job training basis within the combat zone. This, of course, is an unacceptable precept for a military which prides itself on broad scale combat readiness. It is also unrealistic to assume that a surgeon spontaneously converts into an expert manager of combat injuries by merely donning a uniform. Under field conditions, even a surgeon with extensive experience in civilian surgery may make costly mistakes in managing traumatic injuries. In the combat setting many accepted surgical proce-

crush, and burn injuries of a type and extent rarely seen in civilian life, but he must often do so within extremely austere settings, often under dangerous, hostile conditions.

Within a combat environment, in contrast to civilian practice, tactical and institutional priorities may also dramatically affect the nature of medical care. For example, the military system for providing surgical care through echelons of increasing sophistication, in which each echelon does only as much as is necessary either to return the casualty to duty or to evacuate him safely to the next echelon, has no direct civilian equivalent. The capabilities of each echelon may also vary from moment to moment, depending upon work load, availability of qualified personnel, and innumerable logistic considerations. War surgery is *not* synonymous with civilian trauma management.

dures and techniques which may have worked well in civilian practice may jeopardize the patient's chances for survival.

Training a military medical establishment to shift its rules of professional performance into a "combat mode" is not easily accomplished. Unfortunately, in pursuit of this goal, civilian-based models for trauma management are currently being utilized to prepare our military medical personnel for war. Advanced Trauma Life Support (ATLS) is the principal program in this effort. Although the pseudonym "Combat Casualty Care Training" is used, this military program neglects many lessons learned in previous military conflicts. In addition, this civilian-oriented policy presupposes the Vietnam model of unfettered air superiority with rapid helicopter evacuation of the critically injured to high-tech, relatively fixed medical facilities (e.g., fleet hospitals), within easy flying distance of the forward extent of the battle zone.

Training dogma fails to emphasize that tactical conditions in future conflicts may be *unlike* that faced by our military forces in Vietnam where, for example, classical military medical doctrine often gave way to the civilian philosophy of casualty triage, with major effort being first directed to the most seriously injured.

ATLS: Its Role in Civilian Trauma Care

The ATLS program of the American College of Surgeons has facilitated broad scale education of physicians and others in a rational systematized approach to management of victims of trauma. Its genesis evolved in response to a demonstrated need for upgrading and broadening a basic appreciation for fundamental principles of trauma patient management in our accident-prone society. Although its principles are readily adaptable to the early phases of care for victims of any form of trauma, it is nonetheless based upon expected standards of care in a civilian setting.

The quintessential expression of battlefield trauma is the casualty with multiple fragment wounds involving trunk and extremities. There is no direct civilian analogy except for the occasional casualty with a shotgun injury. This highlights an important weakness in the employment of ATLS in the training of military medical officers.

Combat casualties *do not* have the same propensity for blunt trauma, cervical spine injury, upper airway problems, etc., as do civilian trauma victims. Instead, the majority of combat casualties have minimal to moderately severe soft tissue wounds with a liberal admixture of contaminated open fractures and visceral injuries.

In one recent study of combat injury survivors in Vietnam, over one-half had uncomplicated soft tissue wounds; one quarter had injuries requiring laparotomy, craniotomy, or vascular reconstruction. The remainder had open fractures.(*2*) This is also consistent with most major military engagements since World War II (Table 2).

What is the applicability of what are now known as ATLS lifesaving skills in the combat injury setting? Statisticians analyzed the Wound Data and Munitions Effectiveness Team (WDMET) data from Vietnam in 1970 relative to casualties who left the field alive. They determined that airway obstruction was seen in only 0.7 percent of casualties. Another 0.6 percent

Iwo Jima 1945: An abandoned Japanese air raid shelter serves as a first aid station during the battle of Iwo Jima.

required airway control for ventilation due to severe neurologic injury. Difficulty breathing due to a chest wall injury (open or sucking chest wound) was seen in 1.6 percent. Difficulty breathing because of an internal chest injury (hemo- or pneumothorax) was seen in another 1.6 percent. Ten percent of the casualty population was judged to have been in shock. Further analysis of the WDMET data indicated that the probability of a living combat casualty presenting with both a possible cervical spine injury and the need for concomitant airway control was less than 1 in 100,000.

ATLS provides a formal plan for ruling out many serious conditions, few of which seem to afflict combat casualties. Thoughtfully excluding a large number of unlikely diagnoses is obviously not equivalent to treating the actual injury. Although it may be useful to know and practice the ATLS algorithm for the highly unlikely maneuver of intubation of a casualty with a possible cervical spine injury, the practitioner of combat casualty care will obviously find it far more valuable to possess the skills necessary for caring for an uncomplicated soft tissue wound.

TABLE 2
Location of Wounds in Hospitalized Casualties by Percent—U.S. Army in Three Wars

	World War II	Korea	Vietnam
Head and neck	17	17	14
Thorax	7	7	7
Abdomen	8	7	5
Upper extremities	25	30	18
Lower extremities	40	37	36
Other sites	3	2	20*

The similarity of wound location is striking and can be seen equally well in Israeli data from 1973 and 1982, as well as British data from the Falklands.

*Including multiple wounds

TABLE 3
Percentage Returns to Duty Overseas by Living Wounded, by Body Region Injured*

Region Injured	Percent Returned to Duty
Head, face, neck	13
Thoracic	11
Abdominal	6
Upper extremity	31
Lower extremity	39
Total:	100

Seventy percent of returns to duty overseas are extremity wounds; the remainder are light and moderate wounds in the other regions.

*Based on World War II aggregate data

How Easily Are ATLS Principles Applied in the Tactical Setting?

The results of combat casualty care, moreover, cannot be fully understood without consideration of the context of the tactical situation. The latter determines the number and types of casualties and obviously places constraints upon the nature of field medical care available. In a survey of potentially salvageable casualties who died in the field, among the 6,000 Army casualties studied by the WDMET team in Vietnam, this is made exceedingly clear. Two died of upper airway obstruction, 10 died of tension pneumothorax, and between 24 and 36 exsanguinated from a wound where first aid could have controlled the bleeding. Unfortunately, for most of these aforementioned casualties, the tactical situation was such that the provision of appropriate intervention would have exposed the rescuers to grave risk.

In essence, few casualties, even when those who were killed in action are considered, would have benefited at the medical treatment facility level from the emergency lifesaving skills emphasized in the ATLS course. Wound dressing, extremity splinting, and starting IV's do not fall exclusively within the province of ATLS, and can be achieved with equal effectiveness by nurses and corpsmen. Even considering the relatively few casualties who might benefit from the ATLS lifesaving skills, immediate surgical intervention will inevitably be required as well,

in order to sustain their ultimate longevity. As such, uniquely military surgical skills and surgical judgment are of paramount importance.

Incompatibilities Between Current Combat Casualty Care Training and Institutional Priorities

Field commanders depend heavily upon early return to duty of personnel temporarily disabled due to disease or injury. Both this concept, however, and ATLS represent two mutually incompatible facets of combat casualty care. It is highly unlikely that a casualty who requires emergency intubation, a chest tube for a tension pneumothorax, or a pericardial tap is going to return to duty. The combat casualty who requires emergency intubation has an upper airway obstruction because of severe maxillofacial trauma or major intracranial injury and will not return to duty.

Seventy percent of those casualties who do return to duty are those with relatively uncomplicated soft tissue wounds of the extremities (Table 3). The remainder of those returned to duty have sustained light and moderate wounds in the other regions (Table 4). Unless we prioritize training for military physicians to facilitate the rendering of definitive treatment to these casualties with soft tissue wounds, we will never conserve the fighting strength.

The Problem. One can justifiably speculate whether the act of clothing students in combat fatigues and conducting the ATLS course in a field setting necessarily prepares physicians for realistically implementing the highly specialized care requirements of military casualties. The medical skills taught in many combat casualty care courses have limited applicability to the majority of combat casualties. ATLS is obviously not a logical substitute for the established principles and essential skills required for the performance of war surgery. It is hardly a qualifying mechanism for establishing expertise in management of battlefield maxillofacial or vascular injuries, large scale soft tissue and visceral injuries, or orthopedic and thoracic wounds.

What Must We Do? Ultimately, the casualty must be given definitive treatment. Military physicians require the skills necessary to treat those surgical problems which constitute the overwhelming majority of combat injuries. Inevitably, a formal course in war surgery must be established, which lays before its students the realities of their responsibilities in the wartime setting. The planning and the content of such a course must reflect the needs and capabilities of forward located medical units, dedicated to maximal return to duty of the minimally

TABLE 4
Frequency of Wounds by Location

Location of Wounds	Frequency Per 1,000 Wounds
Head	
Intracranial	19.50
Scalp*	37.75
Eye and ear	20.00
Neck	20.70
Maxillofacial	
Bone	12.20
Soft tissue*	46.80
Chest	
Intrathoracic	46.40
Superficial*	37.30
Spine	9.40
Abdomen	
Intra-abdominal	28.40
Thoraco-abdominal	11.00
Intra-abdominal and thoraco-abdominal	5.58
Superficial*	7.40
Extremity	
Deep muscle	368.00
Complete fracture	126.50
Traumatic amputation	29.50
Superficial*	149.80
Other	23.00
Total:	999.23

Based on aggregate World War II data from all theaters

*Most returns to duty will emanate from these groups.

injured. Highest priority must be assigned to forward located surgical care in the austere combat setting. Reliance upon the "scoop and run" helicopter system of the Vietnam years, which flushed large numbers of potentially salvageable, minimally injured casualties far to the rear with little likelihood of return to duty, may prove counterproductive in the future.

A retired combat surgeon wrote, "Historically, clinical policy guidance relative to casualty care in the U.S. service medical departments has varied enormously with the managerial style of each Surgeon General. On occasion, there has been tight quality control, technical clinical policy guidance, and careful gathering of hard data. Most, however, have adopted a laissez-faire approach, assuming that qualified surgeons, given the correct equipment and supplies, would somehow perform the correct procedures. This is a fallacious and extremely dangerous assumption. *It is important that updated clinical guidance for the care of the combat wounded, in keeping with current progress in the discipline of surgery, be continuously operative for proper combat casualty care."(3)*

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The following outline embodies the broad spectrum of knowledge synonymous with combat casualty care. Selective implementation of practical facets of this knowledge base for any war surgery curriculum should follow careful assessment of institutional needs. This should be accomplished by surgical educators who are free of the opinions, fantasies, and proprietary interests ingrained by the Vietnam experience. The existence of convenient civilian-oriented educational "packages," labeled Advanced Trauma Life Support, or Advanced Cardiac Life Support, should not distract them from studious assessment of specific patient and organizational needs, both past and present.

Combat Casualty Care

Mechanisms of Combat Injury

1. Wounding agents: artillery, guns, rifles, mines, booby traps, and bombs.
2. Ballistics: the relationship between missile design, velocity, and character of wounds.
3. Explosive blast injuries: etiology and pathophysiology.
4. Crush injuries: pathophysiology.
5. Burns (including napalm, mustard vesicants, and phosphorus).
6. The changing technology of warfare and its application to wounding.

Initial Casualty Care Within Forward Echelons

1. Techniques and principles of injury assessment.
2. Prioritizing care in the combat patient with multiple injuries.
3. Airway management in the field (including the burn setting, as well as following head and neck trauma).
4. Vascular access techniques.
5. Principles of field resuscitation and shock management.
6. Burns and smoke inhalation at sea: initial management.
7. Forward medical treatment in a chemical environment.
8. Casualty sorting: triage.

Further Sequential Echelon Management of Casualties

1. Anesthesia and analgesia in forward areas:

A. Field anesthesia systems (U.S., NATO, and other nations).

B. Techniques for spinal and local anesthesia in the field.

C. Choices of technique for particular conditions and injuries.

D. Special conditions affecting anesthesia in forward areas.

E. Techniques for physiologic monitoring in the field.

F. Ventilatory support in the field.

G. Pain control within and between echelons.

2. Early management of maxillofacial injuries.

3. Early management of head injuries: penetrating, blunt, and blast.

4. Neck injuries: single (or combined) larynx, trachea, pharynx, esophagus, or vascular wounds.

5. Crush and penetrating chest injuries, including thoraco-abdominal wounds: early management, including limited thoracotomy for control of pulmonary bleeding and air leaks.

6. Early treatment for injuries of the spinal cord and cauda equina.

7. Drowning, frostbite, and heat stress injuries.

8. Smoke inhalation injuries: management in an echeloned system.

9. Burns at sea/on land: management in an echeloned system.

10. Burn management where evacuation is delayed.

11. White phosphorus burns and vesicant (mustard) burns.

12. Wounds of soft tissue: techniques of wound management: excision, incision, debridement, and delayed primary closure:

A. White phosphorus tissue wounds: special considerations.

13. Infection in battle wounds:

A. Aerobic and anaerobic infections, including gas gangrene and tetanus.

B. Choice of antibiotic treatment in forward areas.

C. Surgical management of infected soft tissue wounds.

14. Missile injuries involving bone: early management by the field surgical team, including the place of external/internal fixation techniques.

15. Vascular injuries: initial management in the field and techniques of operation.

16. Lower extremity injuries: management in forward echelons, combining general insights from preceding subject headings with unique aspects of medical management for wounds from mines and booby traps.

17. Amputations:

A. Traumatic amputation.

B. Differential indications for early/late surgical amputation.

18. Upper extremity injuries in combat:

A. Injuries with combined vascular and orthopedic components.

B. Hand injuries: initial management.

19. Early surgery of the abdomen and pelvis:

A. Operative approaches.

B. Regional injuries: basic principles of management:

(1) Solid visceral injury.

(2) Small/large bowel injuries.

(3) Wounds of the extraperitoneal rectum.

(4) Vascular injury.

(5) Urinary collecting system wounds.

20. Blast injuries: initial treatment.

21. MEDEVAC: medical considerations prior to either AIREVAC or protracted ground transport.

Treatment in the General Hospital Area

1. Chest injuries: rear echelon treatment:

A. Management of persistent bleeding, air leak, trapped lung/empyema, retained missiles.

2. Reoperative abdominal surgery:

A. Dehiscence.

B. Missed intra-abdominal injury (with/without prior laparotomy).

C. Intestinal obstruction.

D. Stress ulcer hemorrhage.

E. Hemorrhage secondary to intra-abdominal lesion.

F. Infection: intra-abdominal and pelvic abscess, sepsis.

G. Abdominal wall defects.

H. Fistulae: GI/urinary with/without cutaneous communication.

I. Retained surgical sponges.

J. Intestinal anastomotic breakdown.

K. Retraction of colostomy.

3. Delayed management of vascular injuries:

A. Techniques of operation.

B. Complications of vascular repairs.

4. Management of missile wounds involving long bones and/or joints.

5. Delayed amputations: indications and management.

6. Foot wounds: management.

7. Hand wounds: management.

8. Neurosurgical management of brain, spinal cord, brachial plexus, peripheral nerve, and cauda equina injuries.

9. Maxillofacial wounds: rear echelon management.

10. Injuries of the ear: hearing, balance, and cosmetic considerations.

11. Delayed management of urinary injuries and wounds of the external genitalia.

12. Complications of the seriously injured:

A. Delayed complications of crush injuries.

B. Delayed complications of explosive blast injuries.

C. Surgical nutrition: its place in combat injuries.

D. Gas gangrene.

E. Post-traumatic pulmonary insufficiency: pathogenesis and management.

F. Acute renal insufficiency in combat injuries: principles of management. □

Fecal Occult Blood Testing

Problems, Pitfalls, and Diagnostic Concerns

LCDR David A. Johnson, MC, USNR

Fecal occult blood screening of asymptomatic persons yields 2 to 6 percent positive tests. If annual screening recommendations (American Cancer Society) were universally implemented, 3 million asymptomatic Americans would have a positive result and should receive further testing. Diagnostic evaluation for this group would cost between $500 million and $2.5 billion dollars. The implementation of colorectal cancer screening therefore has a major impact on physician time and medical economics. Evaluation of asymptomatic patients with a positive test for fecal occult blood should be thorough but cost-effective. The goals of this discussion will focus on:

- The chemical tests for fecal occult blood testing (FOBT) currently available.
- Sensitivity/specificity data for colorectal neoplasia.
- Technical factors influencing the chemical reaction.
- Cost of FOBT (direct, indirect, "hidden").
- Significance of a positive FOBT in select patient populations.
- Evaluation for patients with a positive FOBT.

Nature of the Reaction

Most of the chemical reactions for FOBT depend upon the oxidation of a phenolic compound to a quinone structure, which then changes color by an intermolecular reaction. Hydrogen peroxide facilitates the oxidation process, which is catalyzed by a number of naturally occurring peroxidases and catalases (including hemoglobin). A chemical reaction occurs with the oxidation of guaiac to quinone structure, which causes a blue color change.

Chemical alteration of hemoglobin as it passes through the gastrointestinal (G.I.) tract can diminish its peroxidase-like activity and render stool tests negative. This is accelerated by pancreatic juice and trypsin. Because of this, occult upper G.I. bleeding is more likely to go undetected than a similar bleed from the lower tract. There is variability in this regard however, and this general rule is therefore not applicable to clinical settings.

Methods of Testing

There are several commercial tests available for FOBT. These are profiled in Table 1. Most of these tests are based on guaiac impregnated paper except for Hematest, which is based on orthotolidine and HemoFec, which uses a tetramethylbenzidine as the indicator reagent. Newer methods of testing for occult fecal blood have distinct advantages and are summarized in Table 2.

HemoQuant is a unique quantitative assay for FOBT. This assay is based on removal of iron from hemoglobin-heme and assay of the fluorescence from the derived porphyrins. This test gives a quantitative recovery of not only intact heme, but also hemoglobin already degraded during gut transit—the "intestinal converted fraction." Thus, HemoQuant should detect both upper and lower G.I. bleeding with equal sensitivity. Additionally, comparison of the converted fraction with total fecal heme may approximate the level of a bleeding source. An immuno-

TABLE 1

Methods of Testing

Guaiac	*Orthotolidine*	*Benzidine*
Hemoccult II		
Fecatest	Hematest	HemoFec
Quik-Cult		
Coloscreen		
Fecult		
Colo Rect		
Haemoscreen		
Hema Check		
Camo Pak		
Occult-Alert		

TABLE 2

New Methods of Testing

1. *HemoQuant: Quantitative Assay*
   - Based on removal of fe from HBC-heme and assay of fluorescence from derived porphyrins
   - Intact heme and "intestinal converted fraction"
   - Not influenced by stool hydration storage, dietary peroxidases, iron ascorbic acid

2. *Immunochemical Detection*
   - Specific detection of human HBG
   - Free of cross-reactivity: food stuffs, animal heme, drugs, etc.
   - Stability for up to 30 days
   - Disadvantages: time delay, complexity, cost

chemical technique for FOBT has been recently developed. This technique reportedly allows specific detection of human hemoglobin and does not cross-react with the various foods, animal heme, drugs, etc., which may influence tests.

The accuracy of the chemical methods for detection of occult fecal blood is determined by comparison with quantitation of -51 Cr-labeled red blood cells. The latter method is generally accepted as the most accurate indicator of intestinal blood loss. Using this as the gold standard, "normal" G.I. blood loss appears to be 0.5 to 2.0 ml/day.

Specific Test Sensitivity/Specificity

The value of a screening test depends on its ability to separate those who have a disease from those who do not. Sensitivity is defined by the proportion of diseased subjects who have a positive test result. A recent study compared the sensitivity of Hemoccult with HemoQuant in the detection of colonic neoplasia. For identification of all colon cancer, asymptomatic colon disease, and adenomatous polyps that measured 2 cm or larger, the Hemoccult test was positive in 67 percent, 43 percent, and 17 percent respectively, and the HemoQuant was positive in 97 percent, 100 percent, and 58 percent respectively. Hemoccult, which does not react with degraded heme, was less likely to detect proximal then distal lesions. A concern here is that the current trend toward right-sided colon neoplasms may be paralleled by an increasing rate of false-negative guaiac tests.

The specificity of a test refers to the proportion of nondiseased subjects who have a negative test. In general, the sensitivity is traded off the specificity to maximize the cost-effectiveness of a diagnostic evaluation. The predictive value, i.e., the proportion of a positive test actually due to the disease in question, is critically dependent on the specificity. The predictive value of a positive FOBT for colonic neoplasia is high and increases with age. Results of a 10-year Hemoccult stool test screening program for colorectal cancer at Memorial Sloan-Kettering Cancer Center is shown in Table 3.

In light of the extreme variability in sensitivity using Hemoccult testing for detection of colonic neoplasia, any positive test should be fully pursued with diagnostic evaluation. As such, clinicians should do everything possible to exclude factors that can falsely influence the test results. As mentioned, guaiac testing is not specific for human hemoglobin and a variety of foods and medication can affect the results (Table 4). HemoQuant is not influenced by intake of medicinal iron but is, however, by ingested red meat. The immunochemical methods are allegedly free of cross-reactions with various food stuffs, animal heme, or drugs. Dietary and chemical restrictions for these test subjects can therefore be eliminated. The immunochemical method requires extensive further study but holds great promise for future widespread use.

Other agents can affect the test interpretation under certain circumstances. Cimetidine can produce a false-positive test of gastric aspirates but does not do the same with stool specimens. Povidone-iodine, used as a topical antiseptic or a douche, will produce positive reactions due to the strong oxidative properties of iodine. Barium sulfate in the stool (after G.I. X-ray examination) does not influence the reaction, although laxatives may diminish both false-positive and false-negative results. The belief that falsely positive guaiac tests can be produced by glycerol guaiaccolate (a cough medicine) has been refuted. If stools are preserved in formalin, a false-positive benzidine reaction may be seen. High residue diet does not influence the reaction.

Slide storage and rehydration can also influence FOBT results. Although a strong reaction will remain positive for

TABLE 3

Neoplastic Findings in Patients With Hemoccult Positive Test Results

Age (Years)	*Adenomas (Percent)*	*Cancers (Percent)*
40-49 (n=68)	15	3
50-59 (n=121)	31	10
60-69 (n=151)	42	13
$\geq$ 70 (n=52)	60	23
Total (n=392)	36	12

TABLE 4

Dietary Peroxidases Equivalent to 1.0 ml Blood

Food	*Mass of Food*
1. Broccoli, Turnips	5 gm
2. Rare red meat, cantaloupes, cauliflower,* red radishes,* parsnip*	5-10 gm
3. Artichokes, bean shoots,* cucumbers, French beans, lemon rinds, mushrooms, parsley,* zucchini*	10-20 gm
4. Grapefruits, carrots,* cabbage, potatoes, pumpkin, figs*	20-50 gm
5. Peaches, celery, lettuce, pickled peppers, silver beets	50-100 gm
6. Blackberries, pineapples, watermelons, walnuts, mint, peppers (red/green)	100-500 gm
7. Bananas, grapes, pears, plums	500 gm
8. Well-cooked red meat, apples, apricots, olives, raspberries	1,000 gm
9. Roast chicken, turkey (boiled), tuna, liver, kidney, brain, pork, rabbit, raisins, oranges, lemons, strawberries, tomatoes	No detectable peroxidase

*No peroxidase detected when reassayed after 20 minutes at 100° C.

at least 10 days, a weakly positive Hemoccult reaction may become negative or equivocal after 2-4 days of storage. Precisely how the chemical reaction is altered has not been determined, although the clinical implication of a potential false-negative screening test is readily apparent. Rehydration of slides has been suggested as a way of enhancing sensitivity and restoring positive reactions. This rehydration, however, also increases the false-positive rate presumably by reactivating a variety of interfering peroxidases. In one screening program, hydration of Hemoccult II slides increased overall screening positivity from 3.7 to 5.4 percent, but corresponding predictive value for neoplasia dropped from 44 percent to only 19 percent. The benefit of the slide hydration, therefore, is probably outweighed by an unacceptable decrease in test specificity.

A strict protocol for stool collection should be followed if stools are to be tested for blood occult (Table 5). Factors known to influence guaiac testing should be avoided for 48 hours before the first stool collection and not resumed until all stool specimens have been obtained. Avoidance of red meat is recommended for 4 days if HemoQuant is used. For screening purposes, specimens should not be taken if blood is actually seen in the stool or urine, or if the patient is menstruating. Whether or not a gentle digital rectal exam can affect a false-positive Hemoccult test by rectal irritation at the time of the exam is not known. Ideally, we would recommend that FOBT be done on spontaneously passed stools. This might also curb the conditioned response of most physicians to feel obligated to Hemoccult test patients every time they do a rectal exam. In our experience, most of the patients who have Hemoccult testing at the time of a rectal exam have not eliminated the dietary and medicinal factors that are known to cause false-positive Hemoccult testing.

By following a protocol for stool collection and FOBT, the false-positive rate for Hemoccult II is 1 to 3 percent. Variance in this range has significant cost impact. If, for example, an underlying 1 percent true-positive rate is assumed, with 1 percent false-positive, about 50 percent of positive Hemoccult tests will come from patients with neoplasia. If false-positive rate is increased to 3 percent, only 25 percent of positive Hemoccult tests will come from patients with neoplasia. The accordant cost-effectiveness of diagnostic evaluation in such patients is significantly lowered.

The significance of occult G.I. bleeding during anticoagulation therapy or while taking anti-inflammatory drugs has recently received attention. From these studies it is apparent that G.I. bleeding cannot be arbitrarily attributed to the anticoagulation or anti-inflammatory drugs per

se but should prompt a thorough diagnostic evaluation.

The increased participation in competitive running has brought attention to the fact that some G.I. blood loss may not be unusual. In prospective studies stool specimens converted from Hemoccult negative to positive in 8 to 23 percent. In competitive runners this may be associated with iron deficiency anemia in the absence of definitive G.I. pathology. Hematochezia following a marathon race was seen in 6 percent of patients in one study. Gastrointestinal bleeding risk appears to be independent of age, race time, abdominal symptoms, or history of recent ingestion of aspirin, vitamin C, or steak.

The pathogenesis of the G.I. blood loss in runners is still not readily apparent. Hypotheses to date have included both intestinal ischemia and/or some undefined mechanical trauma to the bowel. Although one can legitimately attribute G.I. bleeding to long distance running, evaluation should be directed in the traditional manner as for nonrunning patients. This practice seems prudent until the cause of the bleeding is found.

A Positive FOBT

There is always a possibility that any G.I. mucosal abnormality may bleed sufficiently to produce a positive FOBT. When occult blood is present in the stool of an adult asymptomatic patient, however, blood loss most often originates from the colon. Although benign or malignant lesions of the upper G.I. tract can present with occult bleeding, there is a low yield of tumors when upper endoscopy of radiography is performed when no colonic tumors are seen. In one study only 2 of 26 patients subsequently found to have esophageal cancer had occult blood in at least one of six stool specimens. In a mass screening program of more than 1,000 asymptomatic patients only 8 percent of those with a positive FOBT were subsequently found to have upper G.I. pathology. Clinical observation in asymptomatic patients has shown that the majority of positive FOBT's due to upper G.I. pathology are found in patients with previous gastric surgery.

The explanation for reduced sensitivity of FOBT in detection of upper G.I. lesions is twofold. First, significantly larger quantities of blood must be lost from the upper G.I. tract in order to produce a positive FOBT. Secondly, guaiac slides cannot readily detect blood in unbuffered gastric juice, and these appear to be an inactivation of peroxidase by gastric acid or proteolytic enzymes during transit through the G.I. tract.

Cancer of the small intestine is uncommon, accounting for less than 2 percent of all G.I. tract cancers. As a general principal, in an otherwise asymptomatic adult, benign disorders of the small intestine do not have positive FOBT as the sole presentation of disease.

Barium Enema

Barium enema should be done with air contrast (ACBE) as this technique will detect about 4 percent more colon neoplasms than a single contrast study. Several studies comparing ACBE to colonoscopy have shown that ACBE may miss 25 to 50 percent of polyps less than one cm and 10 to 25 percent of polyps greater than one cm. About 85 percent of the radiologically undetected polyps larger than 5 mm, however, are located in the sigmoid colon and flexible sigmoidoscopy complements ACBE in the examination of this area. Additionally, there are technical limitations in some patients which may limit attempts for an optimal examination, especially of the sigmoid colon. The advantages and disadvantages of ACBE are summarized in Table 6.

Sigmoidoscopy

Fiberoptic flexible sigmoidoscopy should be used in combination with ACBE if colonoscopy is not being used

TABLE 5

Protocol for Stool Hemoccult Testing

1. Two days before the first stool collection and throughout collection period, avoid factors known to affect the result of Hemoccult tests.
2. Beginning on the third day take two specimens (two separate positions) from three consecutive spontaneously passed stools.
3. Avoid testing during active perirectal disease.
4. Promptly return completed Hemoccult cards (six samples).
5. Evaluate all positive results.

TABLE 6

Barium Enema: Advantages and Disadvantages

Advantages	*Disadvantages*
1. Availability	1. Lower sensitivity
2. Cost	2. Nontherapeutic
3. Permanent record	3. Patient tolerance
4. Reduced risks	4. No histologic diagnoses
	5. Technical requirements
	• Recognition of dependent and nondependent surfaces
	• Manipulation of barium pool
	• Adequate distension
	• Colonic preparation

as the primary diagnostic modality for examination of the colon. It is preferable to rigid sigmoidoscopic examination as it leads to detection of at least twice as many polypoid lesions. Patients found to have rectosigmoid neoplasms should bypass the ACBE and have a full colonoscopy to detect and remove, if feasible, any additional lesions. Complete visualization of the sigmoid requires full insertion of a 60 cm sigmoidoscope in more than 75 percent of patients. In an unsedated patient, full insertion is at times difficult and the entire sigmoid is therefore not evaluated. Of further importance is the data from a study which showed that one-third of all mass lesions (in a prospective study of over 600 patients) were beyond the reach of the flexible sigmoidoscope.

Colonoscopy

Colonoscopy is clearly the gold standard for evaluation of colonic lesions. Although not error-free, the "miss rate" for colonic polyps (greater than 7 mm) in one study was only 7.9 percent compared to 27 percent for ACBE. In the Memorial Sloan-Kettering study, patients with a positive FOBT received flexible sigmoidoscopy, ACBE, and colonoscopy. The tumors of 30 percent of those with neoplasia would have gone undetected without colonoscopic examination. The advantages and disadvantages of colonoscopy are summarized in Table 7.

TABLE 7

Colonoscopy: Advantages and Disadvantages

Advantages	*Disadvantages*
1. Single examination	1. Cost
2. High sensitivity	2. Risks
3. Therapeutic	3. Availability
4. Histologic confirmation	
5. Well tolerated	

Diagnostic Testing

Once a screening Hemoccult test is positive in an asymptomatic patient, it cannot be ignored even if subsequent Hemoccult testing is negative. Even if only one of a series of FOBT is positive, a diagnostic workup should be performed. This practice is based on the known variability of bleeding of colonic neoplasia and the lack of homogeneity of hemoglobin in feces. Studies have supported this premise and shown that only 41 percent of cancers would have been detected if only one FOBT smear per day was examined rather than two. Furthermore, greater than 50 percent of participants in some clinical trials have had only one or two of six smears positive by FOBT.

The challenge here lies in choosing the best procedural algorithm that will detect the highest percentage of colonic polyps and cancer with the least risk and lowest cost. Controlling costs means minimizing the direct costs of the procedure and indirect costs of procedural complications, patient anxiety, time lost from work, and evaluation of false-positive tests. The relative strengths and availability of resources in the community must also be considered. Currently colonoscopy is felt to be more effective and less costly than the combination of flexible sigmoidoscopy and barium enema and therefore should be the *initial* diagnostic test in evaluation of FOBT in patients over 50 years of age.

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Psychosis Exacerbated by Thiothixene

An Atypical Case of Neuroleptic Malignant Syndrome

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The following is a case of brief reactive psychosis in which the symptomatology was exacerbated by treatment with a standard antipsychotic agent, thiothixene (Navane).

A 19-year-old male with no prior psychiatric history was admitted to the acute care psychiatry service. The patient, who had just completed Navy recruit training, exhibited thought blocking, paranoid ideation, and loose associations. Routine laboratory workup, which included CBC, urinalysis, and alcohol and toxicology screens, was negative. The physical examination was negative. A history taken from the patient's parents indicated adequate premorbid adjustment. To the parent's knowledge, their son had abused neither drugs nor alcohol. Available historical data tended to indicate the patient had become ill while attempting to engage in behavior which was incompatible with his strict religious upbringing.

In an attempt to allow the patient to recompensate in a structured milieu, he was observed for 3 days without psychopharmacologic intervention. The patient's behavior continued to be extremely disorganized, however, and on the third hospital day he was given 10 mg of thiothixene. He persisted in wandering about the ward aimlessly, disrobing from time to time, approaching other patients as if to talk to them but then only staring blankly.

On the 4th day the patient received a total of 15 mg of thiothixene. His behavior became even more disorganized. His dosage was increased to 35 mg on the 5th day and to 60 mg on the sixth, when he developed significant complications. Throughout the day he exhibited increased thought blocking, disorientation, marked psychomotor retardation, shuffling gait, torticollis, and cogwheeling. He reported auditory hallucinations and appeared quite confused, responding in a bizarre way to comments made to him. In addition to the neuropsychiatric symptomatology, the patient developed a fever to 100.5° F, his pulse increased to 156, and his respirations to 24 per minute. His blood pressure was recorded as 119/92. His pupils were dilated and he was diaphoretic.

Laboratory studies drawn on the 7th day revealed a white blood count of 13,900 with a differential count of 83 segs, 2 bands, 7 lymphs, and 8 monos; AP of 143 IU/L, AST of 102 IU/L, and a CK of greater than 1200 IU/L. Hepatitis-B antigen and mono spot were both negative. A final dose of 10 mg of thiothixene was administered early on the 7th day. Subsequently, the medication was discontinued in light of the patient's marked psychiatric and medical deterioration.

Late on the 7th day, the patient's temperature returned to normal, his pulse dropped to 100, and his diastolic blood pressure dropped to 86. Although the patient's respirations remained rapid (26 per minute), he denied difficulty in breathing.

Over the course of the next 2 days the patient improved dramatically, the previously noted signs and symptoms of psychosis completely abated. By the 17th day, the patient's liver function tests and CK had returned to normal. At a 12-week followup the patient showed no evidence of psychiatric disease.

Discussion

Early in the course of his treatment with thiothixene, the patient seemed to be suffering from an exacerbation of his original condition. Alternatively, his illness was simply progressing on its own. The later manifestations were clearly related to drug treatment.

A rather nonspecific clinical picture of increased psychotic symptomatology after treatment with thiothixene has been described in several studies. (*1-3*) One study documented exacerbation of psychotic symptoms in 30 percent of the patients treated with thiothixene (N=20). The clinical picture of this patient's early difficulties is consistent with Ayd's hypothesis that the activation of psychosis by thiothixene is a manifestation of an overdose and is most likely to occur soon after treatment begins. The abnormalities in liver function tests were seen as being consistent with previous reports of drug-induced changes in particular laboratory values due to administration of thiothixene.(*4,5*)

Although the physiologic and psychiatric symptoms seen in this patient suggest an acute exacerbation of psychosis, these symptoms are also consistent with anticholinergic intoxication. In addition to predictable physiologic symptoms, patients suffering from anticholinergic effects often demonstrate disorientation, incoherence, hallucinations, bizarre motor behavior, fluctuating levels of consciousness, and impairment of recent memory.(*6*)

Prior to the discontinuation of thiothixene, the patient met Levenson's criteria for neuroleptic malignant syndrome (NMS).(*7*) The specific symptoms included fever, elevated CK, tachycardia, tachypnea, diaphoresis, and leukocytosis. The manifestations of NMS appeared around the 6th day of treatment, as the dosage of thiothixene was being adjusted upwards. Shalev and Munitz have noted that NMS often occurs at the beginning of treatment, while doses of neuroleptics are being progressively increased.(*8*) The patient was, however, never gravely ill and did not require the vigorous and intense medical management necessary in florid cases of NMS, such as those reported by Levenson. Thus, this was considered to have been a mild or atypical case of NMS.

This case is one of several seen in which various antipsychotic medications apparently worsened so-called functional psychosis. In other cases the neuroleptic toxicity did not progress to an NMS-like picture. This case amply illustrates that a vicious cycle of treatment is easily established wherein more treatment leads not to recovery but to deterioration.

In prescribing antipsychotics, all clinicians need to be aware that medications which are usually effective in treating psychotic conditions can produce a variety of complications, some mimicking the very condition under treatment. In particular, Navy physicians must be alert to the fact that "boot-camp psychosis," often seen as a matter of routine treatment, may run an unexpectedly malignant course.

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HIV Correction

In the article "HIV Program at Bethesda" (May-June 1988), not all medical board reports on HIV positive patients are referred to the Central Physical Evaluation Board (CPEB), as implied on page 29.

A medical board is convened on each individual following a comprehensive evaluation. However, only those medical board reports on individuals who demonstrate immunological deficiency, neurological involvement, or clinical illness associated with HIV infection are sent to the CPEB to determine fitness for duty. All other HIV positive individuals remain on active duty, unless they have another medical condition which would require referral to the CPEB.

Questions regarding medical board processing can be answered by the patient administration officer at the military medical treatment facility.

Dr. **John J. Bookman**, noted New York diabetes specialist and former World War II naval medical officer and POW, died in an auto accident in New York last March. He was 76.

Following graduation from New York University School of Medicine in 1939, Dr. Bookman began his residency at Mount Sinai Hospital in New York. Just before the war broke out he joined the Navy and was assigned to the Philippines, becoming medical officer in charge of the Navy Section Base Dispensary on Bataan. His duties included providing medical support to the Dewey Dry Dock at Mariveles.

After the fall of Bataan on 9 April 1942, Bookman and many of his comrades fled to Corregidor, where he joined the 3rd Battalion, 4th Regiment, U.S. Marines, and helped defend the beaches against Japanese landing parties.

With the loss of Corregidor on 6 May 1942, Dr. Bookman became a prisoner of war and was interned at the infamous Bilibid Prison in Manila. There he worked in the prison hospital until his transfer in October 1943 to Cabanatuan, a camp north of Manila.

In February 1944 he was shipped to Japan, where he continued to distinguish himself in captivity by running the tuberculosis ward at the Kobe prison hospital. During the B-29 incendiary raid on Kobe on 5 June 1945, he ministered not only to injured allied prisoners in his charge but also to Japanese civilian victims.

Dr. John J. Bookman

After liberation, Dr. Bookman returned home in 1945 and for the past 43 years practiced medicine in New York, becoming a leading authority on diabetes. At the time of his death, he was associate attending physician in medicine at Mount Sinai Hospital, New York, NY.

CAPT **James O. Houghton**, MC, recent commanding officer of the Naval Aerospace Medical Research Laboratory, Pensacola, FL, died 16 June 1988 in an auto accident in Florida. He was 45.

CAPT Houghton was born in 1942 in Littlefield, TX, graduated from Union College in Nebraska, and received his M.D. degree from Loma Linda University in 1968. He completed his internship at Naval Hospital, Philadelphia, PA, in 1969 and was designated a naval flight surgeon in 1970.

Following tours with the First and Third Marine Aircraft Wings in Santa Ana, CA; Da Nang, RVN; and Futemma, Okinawa, CAPT Houghton obtained an M.S. degree in preventive medicine from the Ohio State University. He was then assigned to Pensacola for further training and later served as senior medical officer aboard USS *Oriskany* (CV-34) and USS *Midway* (CV-41) homeported in Yokosuka, Japan. Subsequent to a tour as director of clinical services at Naval Hospital, Key West, FL, he conducted research in acceleration physiology at the Naval Air Development Center, Warminster, PA, and then served as special assistant for aerospace medicine on the Naval Air Systems Command staff.

CAPT James O. Houghton, MC

After a tour as program manager for human performance and aviation medicine at the Naval Medical Research and Development Command, Bethesda, MD, he became commanding officer of the Naval Aerospace Medical Research Laboratory in June 1985. His new position was to be directorate for research and development at the Naval Medical Command, Washington, DC.

CAPT Houghton was a diplomate of the American Board of Preventive Medicine, a fellow of the American College of Preventive Medicine, and an associate fellow of the Aerospace Medical Association. He was posthumously awarded the Meritorious Service Medal. □

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